FEATURE

ELEMENTS OF INFORMATION INQUIRY, EVOLUTION OF MODELS, & MEASURED REFLECTION

Daniel Callison
callison@indiana.edu

Katie Baker
kbaker@sycamoreschool.org

In 2003 Paula Montgomery, founding editor of *School Library Media Activities Monthly* and former branch chief of school media services for the Maryland State Department of Education, published a guide to teaching information inquiry (Callison 2003). Her staff also illustrated the elements of information inquiry as a recursive cycle with interaction among the elements occurring each time the inquirer encounters new information. This cycle is centered on a need or task, no matter how small or large, or how complex or simple (see figure 1). This cycle recurs with each information interaction, whether a portion of a project or culmination of the greater inquiry experience.

In 2003, I (Daniel) defined five elements as a consistent core found in the many models for information searching and use emerging at the time from a variety of academic educators and researchers, as well as from leading school library professionals. These five elements have remained central while there has been evolution in several of the leading information literacy instructional models (Callison and Preddy 2006). Application of constructivist educational theory, as well as refinement of school library instructional practice, resulted in an evolution toward inquiry. While these advancements have moved toward a more student-centered teaching approach, the core information inquiry elements continue to provide the framework for inquiry-based learning.

Five Elements of Information Inquiry

Questioning. This element rests on natural curiosity held by most humans from birth. Who? What? Where? When? How? But most of all, Why? This element, as it interacts with the other four, becomes a more refined skill set. The result is the ability to ask more focused, relevant, and insightful questions.

Questions trigger the interactions that can eventually lead to greater understanding of an environment, a situation, a problem, an issue, or actions of a person or group. Today, these questions are raised in an environment dominated by a flood of information, often unorganized, misleading, and overpowering. Understanding, gaining meaning, and arriving at a solution are the indicators of successful end-products of the inquiry process. Conclusions are also the basis for beginning another set of questions.

Information inquiry is based on a continuous questioning cycle, the essence of lifelong learning.

Exploration. Closely tied to questioning, exploration is the action taken to seek answers to the questions. In many cases, no specific questions are on the agenda, but the drive to satisfy curiosity moves the learner to search for information: reading, viewing, listening. As the information inquiry elements interact and the abilities of the explorer mature, exploration becomes the action to gain information related to specific questions. Exploration becomes a systematic search for and examination of resources and information to meet a need or task that is meaningful and holds purpose for the learner.

Over time and through many cycles of these elements, information needs and tasks become more focused. As a result, exploration involves a more discriminating process to seek and select information. Mature abilities gained through practice and experience result in more efficient use of time to search, examine, and reflect.

Assimilation. This element involves the actions to absorb and fit information with that which is already known, believed, or assumed by the learner. In some cases, assimilation means reinforcing or confirming what is known. In other cases, assimilation involves an altering of what has been accepted as knowledge by the individual learner or group of learners.

Inquiry turns learning into more than a gathering of data. Assimilation through inquiry leads to consideration of a wider range of perceptions and options. As the inquirer matures, assimilation involves linking a host of diverse information to that previously known and applying that information to meet different future situations. Assimilation involves accumulation of knowledge, alteration of accepted knowledge, and constant consideration of alternatives.

Inference. This element involves the actions or processes for deriving a conclusion from facts and premises. Inference may involve personal choice and actions taken based on conclusions that seem most relevant and meaningful for the situation. On a personal basis, inference is usually an internal message to the self and not one that is conveyed in a formal manner to others.

In other cases, inference may involve a wider communication of conclusions. The inference is either shared among members of a group working on the same tasks in a cooperative effort, or the inference is presented to those who might need the recommendation for action or need to evaluate the learner's ability to address a problem and communicate a solution.

Information within the inference element is most useful when it becomes evidence. Evidence is necessary to support a claim, notion, plan for change, or hypothesis. Evidence may be necessary to justify the status quo or accepted norm. Evidence is always necessary to justify change. A new expectation for the Common Core State Standards Initiative is that students learn not only how to find satisfactory evidence, but also determine what *is* the best evidence possible.

Reflection. This element raises the question that brings the interactions of the other elements to a complete cycle. "Have I been successful in answering my question?"

Further, other questions that involve assessment of the information inquiry process extend from reflection. Were the resources used the best possible? What new questions have resulted, and how should they be explored? Is what has been accepted as new knowledge meaningful to me, to others? Has this knowledge been understood to the extent that the communication process is complete? What evaluation of the application of this cycle in information literacy do others have to offer?

As the learner matures in his or her ability, reflection will be used more and more within each element as well as an overall action. Individual reflections to assess exploration, assimilation, and inference are formative. Reflection that is summative in nature allows the learner and teacher to consider decisions connected across the entire project.

The learner who masters self-reflection becomes more likely to be not only a true independent learner but also one who can help others master the information inquiry interactions. Teachers who master both formative and summative assessment processes will provide more clarity in their guidance and feedback in judgment of learning actions. The teacher as a model of

Figure 1. Recursive inquiry cycle. (Callison 2003)

TABLE 1. PATHWAYS TO KNOWLEDGE (Follett Software Company; Pappas and Tepe 2002)

Five Elements or Components of Information Inquiry Questioning Raising the Information Need	Appreciation and Enjoyment	Sensing, viewing, listening, reading, curiosity, enjoyment	
	PreSearch Establish a focus	Develop an overview	Brainstorm, formulate initial questions, build background, identify key words, relate to prior knowledge, explore general sources.
Exploring Reading, Viewing, Listening		Explore relationships	Define questions, cluster, outline, webbing, listing, and narrowing and broadening Provides searchers with strategies to narrow their focus and develop specific questions or define information need Makes a connection between their topic and prior knowledge
	Search Planning and implementing search strategy	Identify information providers	Home and computer resources, museums, zoos, historical sites, libraries, etc.
		Select information resources and tools	Indexes, people, Internet, media, reference resources, etc.
		Seek relevant information	Skim and scan, interview, confirm information and sources, record information, determine relevancy of information, explore and browse widely
Assimilation Accepting, Incorporating, Rejecting	Interpretation	Interpret information	Assessing usefulness of information and reflecting to develop personal meaning Compare and contrast, integrate concepts, determine patterns and themes, infer meaning, analyze, synthesize, classify, filter, organize, and classify
Inference Application for Solution and Meaning	Communication Construct and present new knowledge	Apply information	Choose appropriate communication format, solve a problem, answer a question, and respect intellectual property
		Share new knowledge	Compose, design, edit, revise, use most effective medium such as video, report, mural, portfolio, and animation
Reflection Adjustment for Additional Questioning	Evaluation Think about process and product	Evaluate	End product, effective communication, redefining new questions, use of resources, meeting personal information needs Evaluation is ongoing in their nonlinear information process and should occur throughout each stage. Through this continuous evaluation and revision process that searchers develop the ability to become independent searchers.

reflective behavior will serve as a mentor who learns from mistakes as well as successes.

Comparing and Contrasting Inquiry Elements

Completely independent from my (Daniel's) definitions and based on extensive professional experience of their own, several leading school library educators have established information literacy instruction models that have moved to an inquiry approach. Each will be examined below. While each model has a unique and copyrighted graphic that can be located through the citations provided, the elements of each model have been organized under a standard frame (see table 1) to allow for comparison to information inquiry as well as identification of contrasting elements that bring new dimensions to the inquiry process.

The model developed for Follett Software by Marjorie Pappas and Anne Tepe (2002) moves beyond the basic information inquiry framework in many respects and brings quality literature to the center of the learning objectives, along with the student's needs. Below are some of the actions Pappas and Tepe recommend for students and teachers:

- Foster appreciation and enjoyment of literature and the desire to learn; these are foundational to establishing meaningful inquiry.
- Activate all senses for information intake.
- Do extensive brainstorming that will trigger potential topics for exploration; extend this brainstorming by identifying keywords and reading general resources to determine interests.
- Cluster questions to bring efficiency to the process.
- Encourage students to exercise methods that bring efficient use of time through skimming and scanning.
- Look for matching patterns and themes within answers to question clusters; identifying these patterns and themes enhances prior knowledge and current interests.
- Experiment with a wide variety of communication formats to determine the most effective mode for students' abilities to present and the audience to comprehend.
- Evaluate not only the product but also the process to raise new questions, assess the extent to

TABLE 2. INQUIRY PROCESS (Stripling 2003)

FIVE ELEMENTS OR COMPONENTS OF INFORMATION INQUIRY	STAGES	INQUIRY SKILLS AND STRATEGIES
Questioning Raising the Information Need **Exploring** Reading, Viewing, Listening	Connect	Connect to own experience Connect to ideas of others Connect to previous knowledge and verify its accuracy Gain background and context Establish preliminary contact with idea through observation or experience
	Wonder	Develop wonder questions that will lead to new understandings about key ideas Frame questions using prior knowledge, focus and framework of instructional unit, and different levels of thinking Develop questions to lead to active investigation and decision making Make predictions or hypotheses based on prior knowledge, background information, and preliminary observations
Assimilation Accepting, Incorporating, Rejecting	Investigate	Plan investigation and develop search strategies to find relevant, high-quality information Identify, evaluate, and use multiple sources of information Find and evaluate information to answer questions Take notes using a variety of formats Use information and information technology responsibly, efficiently, and ethically Think about the information to formulate new questions and hypotheses: identify gaps and conflicting information, consider alternatives explanations and predictions, and consider new questions to extend the investigation into a new area
	Construct	Organize information to detect relationships among ideas Draw inferences justified by the evidence Think about the information to test predictions and hypotheses: compare evidence to hypotheses, compare patterns in data with what is already known, use evidence Recognize author's point of view and consider alternate perspectives Construct clear and appropriate conclusions based on evidence, explanations, interpretations, and connections Connect new understandings to previous knowledge
Inference Application for Solution and Meaning	Express	Apply understandings to new context – create a product to demonstrate new understanding Select format based on needs of topic and audience Communicate clearly both main and supporting points in product Use the writing process to develop product (pre-write, write, revise, edit) Evaluate and revise own product based on self-assessment and feedback from others Express new ideas or take action to share learning with others
Reflection Adjustment for Additional Questioning	Reflect	Set high and clear standards for own work Reflect with others Use criteria to assess own process and product throughout the learning; make revisions when necessary Reflect on own learning to be clear about the change in understanding (change in mental model) Adapt own standards and process based on personal reflection and feedback from others Ask new questions, set new goals for learning

Note: *Application of the Information Inquiry Elements to Stripling and Pitts' REACTS model can be found in* The Blue Book on Information Age Inquiry, Instruction and Literacy *by Daniel Callison and Leslie Preddy, Libraries Unlimited, 2006, Table B.6., page 590.*

which use of resources meets information needs, and recognize the degree of movement toward becoming an independent thinker.

Beyond the REACTS Model

Barbara Stripling developed in collaboration with Judy Pitts (1988), Stripling has moved more recently to a process designed to meet inquiry learning projects across the curriculum and at various grade levels (see table 2). Her model is designed as a conversation-planning instrument to be used collaboratively with teachers (Stripling and Harada 2012). Several of her strategies move beyond the information inquiry core to create a greater library-centered and learner-centered experience for students. Among the student learning behaviors she encourages for students—in addition to engaging in the standard information inquiry cycle—are those listed below:

- Find a connection from your experience and ideas to that of others, especially your peers.
- Feel free to wonder about questions that may lead to resources, ideas, and information you have not considered before.
- Establish a focus and framework that will meet academic intellectual demands of the assignment.

- Initiate a plan to find not just relevant information, but high-quality, credible information.
- Identify information gaps and conflicting information, and plan to deal with such issues.
- Look for patterns in data and patterns in conclusions from others.
- Transform information gained to new contexts to determine new meaning based on the strength of the evidence.
- Study the expectations of the audience and tailor your presentation to address those demands.
- Apply self-assessment as much as possible but learn to reflect with others.
- Set new learning goals as part of the total reflection on the experience and make those new goals foundational to future inquiry.
- Understand that maturation in inquiry is the process of building toward new, meaningful mental models.

The most influential model for information literacy instruction has been that created by Carol Collier Kuhlthau: the Information Search Process (Kuhlthau 2003). Her work has extended across public schools and higher education and has been tested in a variety of demanding workplace environments. Her shift to greater emphasis on inquiry strategies is in keeping with her consistent application of constructivist learning theory and assumption that students have the ability to build on their experiences (see table 3). Through the development of Guided Inquiry Design (Kuhlthau, Maniotes, and Caspari 2012), even greater emphasis has been placed on the student as the centerpiece of the learning process. Strategies are designed to guide the student to a meaningful focus for inquiry. Without such, everything else is futile. Examples of ways educators can foster student engagement are listed below:

- Make sure tasks involved in teaching inquiry are complex enough to merit trained, collaborative teaching teams.
- Immerse the students in thinking about what they already know and what would be worth learning; guide the students but support individual effort when of value.
- Encourage students to scan and explore a wide variety of sources, including broad subjects and works at various reading levels.
- Guide students to concentrate question development on issues of importance.
- Expect learners to maintain a record of the research experience and reflect on it regularly.
- Model actions such as visualizing and charting patterns to show growth in understanding and emersion of new knowledge.
- Advocate going broad, beyond the norm, in early exploration, but deep in quality and credibility when a focus has been established.
- Recognize that simple fact finding does not merit the students' or the teacher's time but reaching for new knowledge does.
- Encourage learners to make presentations as interesting for the audience as they are for the inquirers, as knowledge does not become rich and worthwhile until shared.
- Convince learners that self-assessment drives true reflection and recording reflection establishes the foundation needed to mature as an effective inquirer.

Measured Reflections

While the evolution toward inquiry of the information literacy models described here has been dramatic over the past decade, many aspects of reflection remain only slightly considered and some not at all. In 2005 Ross Todd and colleagues at Rutgers University reported that high school students engaged in guided inquiry learning reported several aspects of change in student academic behavior:

- Student's initial knowledge underwent a significant conceptual change.
- Students learned topical content in deep ways, shown in complex and coherent knowledge structures.
- Students became more skillful and confident as information seekers.
- Students became increasingly engaged, interested, and reflective during their learning process and saw information seeking as a constructive process of building both deep knowledge and deep understanding.
- Students gained practical skills in independent information seeking, moving from fact finding to information analysis and synthesis.
- Students showed increasing awareness of the varied quality of information, as well as of information as problematic and often contradictory.

While Todd's work has uncovered new evaluation measures that should be investigated and practiced more, we know very little about the process and value of student reflection, and we know even less about the array of behaviors that could become tangible measures of high performance. Areas that lie before us for further and deeper examination are:

- How do students identify conflicting information, document its differences, and resolve use of that information that seems most credible? How can they document value of primary and secondary sources?

TABLE 3. GUIDED INQUIRY DESIGN (Kuhlthau, et al. 2012.)

FIVE ELEMENTS OR COMPONENTS OF INFORMATION INQUIRY	PHASES	INQUIRY COMMUNITY TASKS	LEARNING TEAM TASKS	STUDENT TASKS
Questioning Raising the Information Need	Open	Invitation to inquiry Open minds Stimulate curiosity	Decide on the learning goals, create powerful opener that invites learners in, establish an inquiry stance, introduce general topic to engage the inquiry community	Spark conversations about ideas and themes, pose questions and problems, and highlight concepts related to the subject
	Immerse	Build background knowledge Connect to content Discover interesting ideas	Design engaging ways for students to immerse in the overall content ideas	Think about what they already know and what seems particularly interesting, curious, surprising, or troubling
Exploring Reading, Viewing, Listening	Explore	Exploring interesting ideas Look around Dip in	Guide students to browse and scan a variety of sources and encourage them to keep an open mind as they explore and reflect on new information	Survey (dip into) a wide range of sources, read when they find something interesting, reflect on questions that begin to shape their inquiry
	Identify	Pause and ponder Identify inquiry question Decide direction	Introduce strategies that enable each student to sort through information and ideas to clearly articulate a meaningful inquiry question that will frame the rest of the inquiry	Construct an inquiry question from the interesting ideas, pressing problems, and emerging themes they have explored
Assimilation Accepting, Incorporating, Rejecting	Gather	Gather important information Go broad Go deep	Guide students in structured approach for managing their search: locating, evaluating, and using information that leads to deep learning	"Go broad" to find a range of sources that are useful for understanding their inquiry question "Go deep" and choose a core of the most useful sources to read closely as they find connections and construct personal understanding
Inference Application for Solution and Meaning	Create	Reflect on learning Go beyond facts to make meaning Create to communicate	Guide students to go beyond simple fact finding and reporting and to summarize, interpret, and extend meaning of what they have learned and create a meaningful, interesting, clearly articulated, well-documented presentation that tells the story of what they have learned in the inquiry process	Reflect on all they have learned about their inquiry question, construct their own understandings, and decide what type of presentation will best represent their engaging ideas, controversies, and theories generated through the inquiry for a particular audience
	Share	Learn from each other Share learning Tell your story	Organize share sessions to provide the best conditions for students to learn substantial content from each other	Share the products they have developed to communicate what they have learned in an interesting, informative way
Reflection Adjustment for Additional Questioning	Evaluate	Evaluate achievement of learning goals Reflect on content Reflect on process	Guide students in reflection for self-assessment of their content learning and progress through the inquiry process; evaluate students' achievement of the learning goals	Reflect on their content learning and learning throughout the inquiry process

Note: *Application of the Information Inquiry Elements to Kuhlthau's Information Search Process can be found in* The Blue Book on Information Age Inquiry, Instruction and Literacy *by Daniel Callison and Leslie Preddy, Libraries Unlimited, 2006, Table B.3., page 587.*

How can they document and reflect on dealing with bias? (Fitzgerald 1999)

- How do students deal with encountering new information that could dramatically shift the focus of inquiry and push it beyond the timeframe usually determined by an assigned structure for the project? Some have suggested that existing inquiry learning models do not include advice for educators or students dealing with such situations (Erdelez, Basic, and Levitov 2011).
- How can students reflect on their experiences and document reasons for advancing in the inquiry process through a cognitive apprenticeship provided by a qualified school librarian or other teacher acting as a research mentor? (Tilley 2006)
- What methods of gathering original data are best suited for various student ability levels and how can they be taught within an inquiry context? Can students document how they can improve in the application of those methods in future inquiry? (Callison and Preddy 2006)

- How do students illustrate their original data through graphics they produce, such as tables and charts? Do these become more precise with each new inquiry experience and does the student mature in his or her use of technology to construct such illustrations? (Lamb and Callison 2012)
- In what manner can students document their reflections on best and worst resources examined so that they may demonstrate more effective and efficient search strategies as they mature in the inquiry process? How can they best test the credibility and usefulness of evidence? (Callison 2015)

A portfolio of student products in inquiry learning should be compiled to show how the student has grown intellectually and matured in the information inquiry process. (Callison 1993). The Common Core States Standard Initiative and the American Association of School Librarians' standards crosswalk provide progressive frameworks for this assessment process over the duration of the student's academic career.

Daniel Callison *is professor emeritus in library science, instructional systems technology, and adult education at Indiana University, Bloomington. He is former director of the IU school library program, ranked among the top ten in the nation. Callison is the author of the forthcoming book* The Evolution of Inquiry *(Libraries Unlimited, January 2015).*

Katie Baker *is a technology integration specialist and computer technology teacher at Sycamore School in Indianapolis, Indiana. She holds a BS and MS in Elementary Education and Educational Technology from Indiana University.*

Tables designed by Katie Baker, computer technology teacher and technology integration specialist, Sycamore School, Indianapolis, Indiana.

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